

# DENIS RIDZAL

OPTIMIZATION AND UQ  
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## EDUCATION

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- 2001–2006: *Rice University, Department of Computational and Applied Mathematics (CAAM)*  
Doctor of Philosophy (GPA 4.03/4.00). Advisor: Matthias Heinkenschloss.
- 1997–2001: *Indiana University–Purdue University at Indianapolis (IUPUI)*  
Bachelor of Science with Highest Distinction (GPA 3.99/4.0).  
Major: Mathematics. Minor: Computer Science.
- 1996–1997: *Friedrich–Alexander Universität Erlangen–Nürnberg, Germany*  
Major: Mathematics, Bachelor of Science Program.
- 1993–1996: *Leibniz–Gymnasium High School, Altdorf, Germany*

## RESEARCH

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(a) NUMERICAL OPTIMIZATION. Numerical solution of large-scale optimization problems. Development, analysis, and implementation of robust optimization algorithms geared toward an efficient solution of problems with large design spaces. Application to nonlinear programming problems in which the constraints involve the solution of partial differential equations (PDEs), such as optimal design, control, and inverse problems.

Recent work: (1) Coupling of component physics using optimization, (2) Numerical uncertainty in PDE-constrained optimization, (3) Sequential quadratic programming (SQP) algorithms with inexact linear system solves, (4) Domain decomposition preconditioners for KKT systems, (5) Development of matrix-free software for the scalable solution of large-scale nonlinear programming problems.

(b) NUMERICAL ANALYSIS AND PDEs. Numerical solution of PDEs using advanced compatible and high-order discretization techniques. Mathematical analysis of finite element methods, including mixed methods, and reformulations based on natural (mimetic) differential operators. Development of a software toolset for PDE-based simulation, whose programming interface supports simultaneous use of finite element, finite volume, and mimetic finite difference discretizations on arbitrary grids.

## PROFESSIONAL EXPERIENCE

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- 2008 – Present: *Senior Member of Technical Staff*  
Optimization and Uncertainty Quantification Department, Sandia National Labs,  
Albuquerque, NM
- 2006 – 2008: *John von Neumann Post–Doctoral Research Fellow*  
Computational Mathematics and Algorithms / Optimization and Uncertainty  
Quantification Departments, Sandia National Labs, Albuquerque, NM
- May–Aug. 2005: *Summer Internship*  
Optimization and Uncertainty Quantification Department, Sandia National Labs,  
Albuquerque, NM
- May–Aug. 2004: *Summer Internship*  
Optimization and Uncertainty Quantification Department, Sandia National Labs,  
Albuquerque, NM

## AWARDS AND HONORS

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- 2006–2008: John von Neumann Post–Doctoral Research Fellowship, Sandia National Labs.

2001–2005:	Presidential Fellowship, Rice University.
2001 and 2004:	George R. Brown Fellowship, Rice University.
2001:	Chancellor’s Scholar, IUPUI Purdue School of Science.
2000:	Chair’s Special Recognition Award, IUPUI Dept. of Mathematics, for achievements at the 60th annual W. L. Putnam Mathematical Competition.
1998–1999:	Anna K. Suter Memorial Scholarship, IUPUI Dept. of Mathematics.
1997–1998:	Member of the “Studienstiftung des Deutschen Volkes”, The German National Academic Foundation.

## PROFESSIONAL ACTIVITIES AND SERVICE

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June 2009:	<i>7th International Conference on Large-Scale Scientific Computations, Sozopol, Bulgaria</i> Organized the special session on “Unconventional Uses of Optimization in Scientific Computing”.
Feb. 2007:	<i>SIAM Conference on Computational Science and Engineering, Costa Mesa, CA</i> Organized the minisymposium on “Numerical Algorithms for PDE-Constrained Optimization”.
Jan.–May 2005:	<i>CAAM Department, Rice University</i> Instructor for the course CAAM 335, Matrix Analysis. Applied matrix analysis and linear algebra, complex variables and applications.
Jan.–May 2003:	<i>CAAM Department, Rice University</i> Teaching assistant for the course CAAM 336, Differential Equations in Science and Engineering. Numerical methods for ordinary and partial differential equations.
Jan.–May 2001:	<i>Department of Mathematics, IUPUI</i> Instructor for a course on general problem solving, for advanced high school students participating in mathematical competitions (work in collaboration with Pavel Bleher).

## PUBLICATIONS

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- P. Bochev, D. Ridzal, G. Scovazzi, and M. Shashkov. Formulation, analysis and computation of an optimization-based conservative, monotone, and bounds preserving remap of scalar fields. Technical Report SAND2010-3021, Sandia National Laboratories, Albuquerque, NM, 2010.
- M. Heinkenschloss and D. Ridzal. A Matrix-Free Trust-Region SQP Method. In preparation, 2010.
- P. B. Bochev and D. Ridzal. An Optimization-Based Approach for the Design of PDE Solution Algorithms. *SIAM J. Numer. Anal.*, 47(5):3938–3955, 2009.
- P. B. Bochev and D. Ridzal. Additive Operator Decomposition and Optimization-Based Reconnection with Applications. In I. Lirkov, S. Margenov, and J. Wasniewski, editors, *Proceedings of LSSC 2009*, Lecture Notes in Computer Science. Springer Verlag, 2009. To appear. Preprint at [https://cfwebprod.sandia.gov/cfdocs/CCIM/docs/bochev\\_ridzal\\_LSSC09.pdf](https://cfwebprod.sandia.gov/cfdocs/CCIM/docs/bochev_ridzal_LSSC09.pdf).
- P. B. Bochev and D. Ridzal. Rehabilitation of the Lowest-Order Raviart–Thomas Element on Quadrilateral Grids. *SIAM J. Numer. Anal.*, 47(1):487–507, 2008.
- D. Ridzal and S. S. Collis, editors. *CSRI Summer Proceedings 2008*. Sandia National Laboratories, 2008.
- M. Heinkenschloss and D. Ridzal. An Inexact Trust-Region SQP Method with Applications to PDE-Constrained Optimization. In *Numerical Mathematics and Advanced Applications: Proceedings of ENUMATH 2007*, pages 613–620. Springer Verlag, 2008.

- P. Bochev and D. Ridzal. Finite Element Solution of Optimal Control Problems Arising in Semiconductor Modeling. In I. Lirkov, S. Margenov, and J. Wasniewski, editors, *Proceedings of LSSC 2007*, volume 4818 of *Lecture Notes in Computer Science*, pages 235–242. Springer Verlag, 2008.
- M. Heinkenschloss and D. Ridzal. Integration of Sequential Quadratic Programming and Domain Decomposition Methods for Nonlinear Optimal Control Problems. In U. Langer, M. Discacciati, D. Keyes, O. Widlund, and W. Zulehner, editors, *Domain Decomposition Methods in Science and Engineering XVII*, volume 60 of *Lecture Notes in Computational Science and Engineering*, pages 69–80, Berlin, Heidelberg, New York, 2008. Springer Verlag.
- D. Ridzal. *Trust–Region SQP Methods with Inexact Linear System Solves for Large–Scale Optimization*. PhD thesis, Department of Computational and Applied Mathematics, Rice University, Houston, TX, April 2006.
- R. A. Bartlett, M. Heinkenschloss, D. Ridzal, and B. G. van Bloemen Waanders. Domain decomposition methods for advection dominated linear-quadratic elliptic optimal control problems. *Comput. Methods Appl. Mech. Engrg.*, 195:6428–6447, 2006.
- P. Bleher and D. Ridzal.  $SU(1, 1)$  Random Polynomials. *J. Statist. Phys.*, 106(1-2):147–171, 2002.
- R. C. Y. Chin and D. Ridzal. Generating orthogonal polynomials for exponential weights on a finite interval. In *Special functions (Hong Kong, 1999)*, pages 42–56. World Sci. Publishing, River Edge, NJ, 2000.

## PRESENTATIONS

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- 11th Copper Mountain Conference on Iterative Methods, Copper Mountain, CO, Apr. 2010: *A Robust Matrix-Free SQP Method for Large-Scale Optimization*.
- NNSA BER Meeting on Transport Equations in Atmospheric Modeling, Sandia National Labs, NM, Mar. 2010: *Optimization-Based Constrained Modeling: A New Transport Paradigm*.
- Invited Presentation, 9th Annual Red Raider Mini-Symposium, Dept. of Mathematics and Statistics, Texas Tech University, Lubbock, TX, Oct. 2009.
- Invited Presentation, Numerical Analysis Seminar, Los Alamos National Laboratory, Los Alamos, NM, Aug. 2009.
- 7th International Conference on Large-Scale Scientific Computations, Sozopol, Bulgaria, June 2009: *Additive Operator Decomposition and Optimization-Based Reconnection with Applications*.
- Workshop on Numerical Techniques for Optimization Problems with PDE Constraints, Mathematical Research Institute, Oberwolfach, Germany, Jan. 2009: *Robust Solution Methods via Optimal Control Reformulation*.
- Invited Presentation, Special Session on Scientific Computing and Advanced Computation, Joint Mathematics Meeting (AMS/MAA/SIAM), Washington, DC, Jan. 2009.
- Invited Presentation, Applied Math Colloquium, Dept. of Mathematics, University of Utah, Salt Lake City, UT, Nov. 2008.
- 5th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008), Venice, Italy, July 2008: *Scalable Solution Methods for Advection–Dominated PDEs Using an Optimal Control Reformulation*.
- John von Neumann Fellowship Lecture, Sandia National Labs, Albuquerque, NM, Nov. 2007: *Analysis and Control of Numerical Uncertainty in PDE–Constrained Optimization*.
- Invited Presentation, Dept. of Mathematics and Statistics, Texas Tech University, Lubbock, TX, Oct. 2007.

- 14th International Conference on Finite Elements in Flow Problems, Santa Fe, NM, Mar. 2007: *A Comparative Study of Galerkin and Mixed Galerkin Methods in Optimal Control Problems with Applications to Semiconductor Modeling*.
- SIAM Conference on Computational Science and Engineering, Costa Mesa, CA, Feb. 2007: *Solution of Optimal Control Problems Arising in the Modeling and Design of Semiconductors*.
- SIAM Conference on Parallel Processing for Scientific Computing, San Francisco, CA, Feb. 2006: *Parallel Solution of Optimal Control Problems Using an Inexact SQP Algorithm*.
- SIAM Annual Meeting, New Orleans, LA, July 2005: *Use of Iterative Linear Solvers in a Lagrange–Newton SQP Algorithm for Large–Scale Nonlinear Optimization*.
- SIAM Conference on Computational Science and Engineering, Orlando, FL, Feb. 2005: *A Sequential Quadratic Programming Framework for Large–Scale PDE–Constrained Optimization*.
- VIGRE Seminar on Simulation–Driven Optimization, CAAM Dept., Rice University, Houston, TX, Feb. 2005: *A Domain Decomposition Preconditioner for Optimal Control Problems Governed by Advection–Diffusion PDEs*.
- ExxonMobil Upstream Research Company, Houston, TX, Jan. 2004: *A General Software Framework for Trust–Region SQP Algorithms*.

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## MEMBERSHIPS

Society for Industrial and Applied Mathematics (SIAM).

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## DEVELOPMENT OF SCIENTIFIC SOFTWARE

<i>Aristos</i>	<p><i>Lead Developer.</i></p> <p>Aristos is a Trilinos (Sandia National Labs) package for nonlinear nonconvex optimization, based on SQP methods. Aristos is specifically designed for the solution of large-scale constrained optimization problems in which the linearized constraint equations require iterative (i.e. <i>inexact</i>) linear solver techniques. Aristos' unique features are the efficient control of inexactness in linear system solves and the scalable solution of NLPs with a very large number (tens of millions) of optimization variables.</p>
<i>Intrepid</i>	<p><i>Lead Developer.</i></p> <p>Intrepid is a Trilinos (Sandia National Labs) library of PDE discretization tools, enabling an element-level mix-and-match approach to implementing compatible and high-order finite element, finite volume, and mimetic finite difference methods for the solution of a variety of PDEs.</p>

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## COMPUTER SKILLS

Programming:	C++, C, Fortran 77, Perl, Matlab, Mathematica.
Libraries:	BLAS/LAPACK, MPI, Epetra (Trilinos Project).
Meshing/Graphics:	Cubit, Tetgen, Triangle; MSTK, MOAB; ParaView, OpenDX.

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## PERSONAL DATA

Spoken Languages:	English, German, Serbo–Croatian.
Citizenship:	USA